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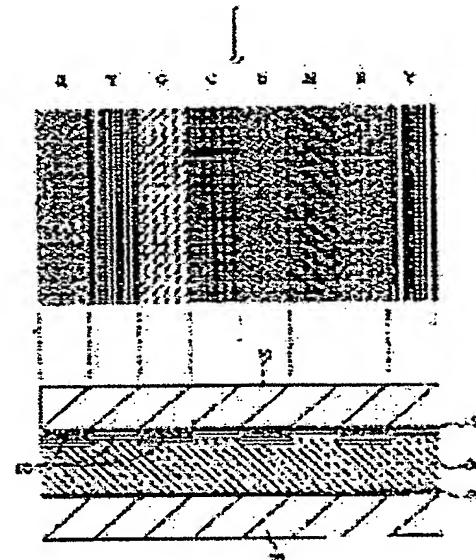
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## (54) COLOR FILTER FOR LIQUID CRYSTAL DISPLAY AND ITS PRODUCTION

### (57) Abstract

**PROBLEM TO BE SOLVED:** To make it possible to produce good colors excellent in color purity even with the primary colors; red, green and blue by further widening the color display range on a chromaticity diagram while effectively utilizing the advantages of the color filters of complementary color systems; yellow, magenta and cyan.

**SOLUTION:** Color filter layers 50 include three colors; yellow (Y), magenta(M) and cyan(C) as color patterns where the one-layer parts consisting of only the one layer of the any one color pattern relating to their color patterns and the two-layer parts superposed with the color patterns of the colors varying from each other in the two layers exist. The color elements of the colors of the complementary color systems of the respective color patterns are formed in the one-layer parts. The color elements of the colors of the three primary color, red(R), green(G) and blue(B) are formed in the two-layer parts. The color of the primary color are obtd. by utilizing the color patterns of the complementary color systems; yellow, magenta and cyan in such a manner and, therefore, the number of the production stages for forming the color patterns is not increased even if the colors of the primary colors in addition to the colors of the complementary color systems are provided.



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## DETAILED DESCRIPTION

## [Detailed Description of the Invention]

## [0001]

[Field of the Invention] This invention is a color filter for liquid crystal displays arranged so that a liquid crystal layer may be faced, and relates to that by which the brightness of the whole color filter is especially thought as important like a reflective mold.

## [0002]

[Background of the Invention] Recently, the reflective mold attracts attention in the liquid crystal display. Since a reflective mold liquid crystal panel can make power consumption small compared with the thing of a transparency mold in that the natural light of the perimeter of equipment is used without using a back light, it is useful as a portable display. It considers as the approach of carrying out color display of this reflective type of thing, and there is an approach using a color filter. The liquid crystal panel of the reflective mold containing a color filter itself equips the whole surface of the liquid crystal layer as an optical shutter with the color filter for color display, and the reflecting layer of the liquid crystal layer which has a light reflex function in a side on the other hand, as each official report of JP,8-304816,A or JP,9-68608,A shows. The method using such a color filter is easy to make a background color into paper White and to aim at the large color specification range, and it is advantageous compared with other methods of not using a color filter.

[0003] By the way, in the liquid crystal display panel of the transparency mold from the former, since a back light is in the tooth back of a panel, as a color filter, a color can use the large thing of the reappearance range of a color deeply. For example, about the brightness of a color filter, it calculates as that to which light passes a color filter once, and the average of the lightness Y value of each color is about 20 to 30 thing, and is enough. Then, generally to the liquid crystal display panel of a transparency mold with a back light, the color filter in three primary colors (that is, red, Green, blue) which was more excellent in respect of the vividness of a color is conventionally used abundantly. However, by the liquid crystal display panel of a reflective mold, the natural light is used for a display, and moreover, since the combination of the color of a color filter itself serves as a white display, the brightest possible thing is needed as a color filter. In that respect, when it calculates as that to which light passes through the inside of a color filter twice, it is needed that the average of the lightness Y value described above from a viewpoint of paper White is 40 or more. In yellow, a Magenta, and the complementary color system of cyanogen, in 50 or more fields, the color reproduction range becomes large rather than this high lightness Y value, the red of the three primary colors [ value / especially / that ], Green, and a blue color filter. Therefore, as a color filter for the liquid crystal displays of the reflective mold with which brightness is demanded, the color rendering range can say that the large complementary color system is more advantageous in the bright range.

## [0004]

[Problem(s) to be Solved by the Invention] From the above point, the artificer etc. made applicable to research the color filter of the yellow which is the point of brightness and was excellent, a Magenta, and the complementary color system of cyanogen, and planned improving the display property further. The greatest difficulty in the color filter of a complementary color system has taken out red, Green, and a color with blue sufficient primary color at the difficult point. Then, employing the advantage of the color filter of yellow, a Magenta, and the complementary color system of cyanogen efficiently, it extends the color specification range on a chromaticity diagram further, and this invention makes it the 1st technical problem to enable it to take out red, Green, and the good color that was excellent in color purity also about blue primary color.

[0005] When solving the 1st technical problem, in addition to the color of yellow, a Magenta, and cyanogen, it is possible as a color element of a color filter to apply the color of red, Green, and blue primary color. However, when in addition to three colors of a complementary color system applying three colors of a primary color system and making it six colors, in having only increased the routing counter which forms the color pattern about each color from 3 to 6, a manufacturing cost is only increased. Then, this invention makes it the 2nd technical problem to enable it to increase the color element of a color filter, without increasing the number of production processes.

[0006] Furthermore, when the number of the colors of a color filter increases, a display screen becomes coarse, for example, only the part whose color number of the increased has a possibility of producing un-arranging — a stripe coming out to a screen. Then, this invention makes it the 3rd technical problem further to make it such a stripe etc. not arise and to perform appropriately color displays, such as monochrome display of an alphabetic character or a figure, or a pattern, respectively.

[0007]

[Means for Solving the Problem] The color filter of this invention is a color filter which made the keynote the color of yellow, a Magenta, and the complementary color system of cyanogen. In a full color display, all the three colors of yellow, a Magenta, and cyanogen are included as a color pattern, but depending on applications, such as 2 color specification, only yellow, a Magenta, and two colors in cyanogen may be included. Such yellow, a Magenta, and the color pattern of at least two or more colors of cyanogen are located on transparency substrates, such as a glass plate, and form a color filter layer as a whole, here — the inside of this color filter layer — yellow, a Magenta, and any one color pattern of cyanogen — much more — since — the becoming part and the bilayer part to which yellow, a Magenta, and any two color patterns in cyanogen overlapped the bilayer are prepared. A bilayer part forms the red and Green yellow and whose Magenta are the three primary colors as Green, cyanogen, and a Magenta form [ red, yellow, and cyanogen ] blue, respectively, and one of blue colors. Thus, since he is trying to obtain the color of primary color using the color pattern of yellow, a Magenta, and the complementary color system of cyanogen, in spite of having the color of primary color in addition to the color of a complementary color system, the number of production processes which forms a color pattern cannot be made to increase. In addition, although the surface ratio of a part and a bilayer part usually sets to 1 further, when performing the display which emphasizes a specific color, area of the color element which participates in the color specification to emphasize can also be enlarged compared with other things.

[0008] Here, in the color filter for the liquid crystal displays of a transparency mold, the color of each color pattern is deep and the thickness is as thick as 1~2 micrometers. Therefore, if they are piled up, a big level difference will arise and the poor orientation and the inconvenient cel gap of liquid crystal will be produced. In what brightness is required as like a reflective mold from it, the color of each color pattern is thin and good for thickness to set 0.7 micrometers ~ 0.2 micrometers to 0.45 micrometers or less more preferably, for example. The upper limit of 0.7 micrometers is a numeric value which avoided the effect by interference of light and was moreover defined again in consideration of raising the lightfastness of the color material in resin (especially color). Moreover, the lower limit of 0.2 micrometers is a numeric value set also to remainder in consideration of color material (especially color) beginning to melt out of resin when it was made thin on processes, such as wet etching. In this invention, such thickness formed primary color in superposition and the piled-up part for the color pattern of a complementary color system partially paying attention to the thin point. In addition, in order that the light which carries out incidence from a perimeter may pass through the inside of a color filter layer twice in the case of a reflective mold, the color should be made thin so that the minimum value of the spectral transmittance in the wavelength of 420nm ~ 610nm of a color filter layer may become 4 ~ 40% in each color.

[0009] Next, the contents of this invention are explained more concretely, taking the gestalt of implementation of this invention into consideration referring to a drawing. Drawing 1 ~ drawing 4 show each example of the color filter by this invention, and drawing 1 ~ drawing 3 are [ a stripe array and drawing 4 ] mosaic arrays. The liquid crystal display panel of a reflective mold itself is equipped with the host guest liquid crystal layer 30 enclosed so that it might insert between two transparency substrates 10 and 20, such as a glass plate around 1mm in thickness, and these two transparency substrates 10 and 20, and it equips with a reflecting layer 70 further the whole surface inside the color filter layer 50 which is the subject of a color filter, and the transparency substrate 20 of another side at the whole surface inside one transparency substrate 10, respectively. And it has the

pixel electrode 60 each other separated on the color filter layer 50 by the side of the transparency substrate 10, and the common electrode which serves as a reflecting layer 70 to the transparency substrate 20 side, respectively. However, this invention can be applied also to the thing of other methods, such as TN method, without being limited to the liquid crystal display panel of a host guest method.

[0010] Now, moreover, the color filter layer 50 has the bilayer part to which the color pattern of a color which is mutually different from a part further only of one layer lapped [one of color patterns] with the bilayer about those color patterns as a color pattern including yellow (Y), a Magenta (M), and three colors of cyanogen (C). Further, a part forms the color element (this color element is also called color pixel.) of the color of the complementary color system of each color pattern, and a bilayer part forms (Red R) Green (G) and the color element of the color of blue (B) in three primary colors. In addition, here may show each color or a color element using the alphabet like Y, M, C, R, G, and B so that it may generally be carried out. In the stripe array shown in drawing 1 - drawing 3, each color of the stripe width of face of Parts Y, M, and C and the bilayer parts R, G, and B is much more the same, and it is about 40-150 micrometers, and the case of the mosaic array shown in drawing 4 is [length and the width of both the magnitude of each forward square-like color element] also about 40-150 micrometers. such an one-layer part and a bilayer part — a stripe or a mosaic — also in which array, it is arranged by turns on the whole surface of the transparency substrate 10. Here, about the pattern configuration of each color pattern, each color (Y, M, C) is completely the same in each array (that is, thing of each drawing). Therefore, although the sequence of patterning differs, it can communalize the mask for forming the color pattern of each color. Moreover, by the thing of drawing 1, by carrying out patterning in the sequence of M, Y, and C, respectively, it is three of the number of the colors of a complementary color system, and the routing counter of patterning can be cleared up by the sequence of C, M, and Y, and the thing of drawing 3 at the sequence of Y, C, and M, and the thing of drawing 2. Drawing 5 shows down stream processing for acquiring the stripe array of drawing 1, and shows that patterning of color pattern 50M of a Magenta is carried out one by one in the process of color pattern 50Y of yellow, and b following it at the process of a by the process of color pattern 50C of cyanogen, and c which continues after that. Also from the drawing 5, the pattern configuration of each color patterns 50Y, 50C, and 50M is the same, and he could understand that the routing counter of patterning is 3. In addition, about each color pattern, what colored resin, such as polyimide, by the color material of a color or a pigment can be used as a pattern ingredient, and it can obtain easily with a well-known photolithography technique etc.

[0011]

[Optics or a display property] About the optics or the display property of a color filter, it usually evaluates with spectral transmittance, a chromaticity, and lightness (average of Y value of each color). When carrying out such evaluation, a value when light passes a color filter once shows spectral transmittance. When the transit route of the light of a reflective mold is taken into consideration about a chromaticity and lightness to it, it is desirable to be aimed at the time of light passing a color filter twice. So, evaluation based on it was performed in this invention. In addition, on the occasion of evaluation, the standard illuminant C in Z8720 of JIS was used. The red which obtained drawing 6 by the superposition of yellow (Y), a Magenta (M), and the color pattern of cyanogen (C) according to this invention (R), They are Green (G) and the spectral characteristic Fig. showing the spectral transmittance about the three primary colors of blue (B). Drawing 7 the usual red (R) in the same lightness Y value (value exceeding a little 40) which boils further and is depended, and Green — they are (G) and the same spectral characteristic Fig. showing the spectral transmittance about the three primary colors of blue (B). according to this invention, by comparing these two drawings, the depth of shade can be enlarged compared with R, usual G, and usual B which boil further and are depended — getting it blocked — it turns out that the range of color specification or color reproduction can be extended. Moreover, drawing 8 is the spectral characteristic Fig. of the yellow (Y) in the thing of drawing 6, a Magenta (M), and the color pattern of cyanogen (C) showing the spectral transmittance about a part (that is, color element of Y, M, and C) further. From this drawing 8, he could understand that the color element of the complementary color system of Y, M, and C is very bright. In addition, according to count the lightness Y value of the color filter of three colors only by the color element of the complementary color system of Y, M, and C of the same property as this drawing 8 turns into a value exceeding 54. Furthermore, drawing 9 shows xy coordinate on the chromaticity diagram by the color filter with the property of drawing 6 and drawing 8, the color specification range by the color filter by this invention from this drawing 9 —

RGB or YMC — compared with the common color filter of three colors, it turns out that it is expanded greatly, respectively. Incidentally, drawing 10 is a chromaticity diagram in the color filter (thing with the spectral characteristic of drawing 7) of RGB3 color formed in the sense of a comparison, and drawing 11 is a chromaticity diagram in the color filter of YMC3 color.

[0012] By the way, in an old color filter, when indicating by multicolor, the drive method which opens liquid crystal in-between by switching the electrical potential difference applied to liquid crystal to a multistage story is taken, but in the color filter of this invention, since color display is carried out in many colors rather than six colors, full color or the color number to display can be made [ many ] by mere ON and combination control of OFF. However, since it increases from 3 pixels of former to 6 pixels in order to express the whole surface and one color, there is a difficulty that a display becomes coarse, in that respect, a color affiliated in said stripe array of drawing 1 carried out — a list — since it is the arrangement which produces a shade periodically, when it indicates by white, there is a possibility that a stripe-like pattern may arise. Although making width of face of a stripe smaller is also considered as a means to prevent this, the method of devising the array of a color element itself is effective. That is, it is the approach of adjoining each other mutually, that is, making the approaching color element complementary color relation like red (R) and (Cyanogen C) Green (G), a Magenta (M), blue (B), and yellow (Y). The thing of drawing 2 – drawing 4 is an array by this approach. In these arrays, two complementary color-related color elements made to adjoin each other mutually can be made into a pair, and it can indicate by monochrome as one unit. Especially the thing of drawing 2, drawing 3, and drawing 4 is suitable for the display of an alphabetic character, a figure, etc. Like before, in order for three colors each of RGB or YMC to perform a monochrome display, these three color pixels must be used for coincidence. Therefore, since two color pixels can perform monochrome display in this invention, compared with the conventional thing which needs three color pixels, a 1.5 times as many high definition display as this can be performed. Moreover, the thing of drawing 2 is excellent in the display of a RGB system, and since a mutually different color far in comparison adjoins each other, when giving an indication in which granularity is not conspicuous, it is advantageous, since R and M are close in the thing of drawing 4. Furthermore, in the thing of drawing 3, since R and M are mutually separated, when displaying a natural color image, it is advantageous.

[0013] Moreover, Y near in color, G, C and B, or R and M can be made into a pair, respectively, and a RGB system can also be displayed. When 1 and the time of making it turn off are considered as 0, as the time of making liquid crystal turn on completely at this time is shown in drawing 12, for example, when displaying the color of G By controlling the value of the electrical potential difference which impresses the color pixel of Y to liquid crystal for the color pixel of G between 0 and 1 to 1, they are G and G+Y (this G+Y shows the color when displaying G and Y in a pair by 1 to 1.). The color of G shown on the line which connects a color pixel can be expressed. Brightness can be earned, although the color purity of the color pixel of G which can be displayed serves as color shifted in the direction of G+Y as the electrical potential difference impressed to liquid crystal is raised in that case, since the color pixel of Y is turned on. The color of the color pixel of G at this time can turn into G and a color between G+Y, can select the color pixel of suitable G according to the property of a display, and can set up G of the color purity of arbitration. Similarly, the color of the color pixel of R is R and R+M (this R+M), the color when displaying R and M in a pair by 1 to 1 is shown. The color which it becomes the color of a between, and R of the color purity of arbitration can be set up, and is the color pixel of B is B and B+C (this B+C shows the color when displaying B and C in a pair by 1 to 1.). It becomes the color of a between and B of the color purity of arbitration can be set up.

[0014] Thus, if the method of presentation using the three primary colors of RGB expressed with the chromaticity diagram of drawing 12 is taken, the display rectangle will serve as the inside of three square shapes which made one on the line of G, G+Y and R, R+M, and B and B+C top-most vertices. Moreover, what is necessary is to face carrying out color display of an alphabetic character, the alphabetic character, etc., and just to use each color pixel, such as RGB and YMC, as it is. In order to bring close and carry out color display of image data like a picture or a photograph to a natural color to it, it is difficult to make liquid crystal drive in consideration of the balance of six colors of RGB and YMC. In that respect, as already stated, the color near a mass color can be performed by making G, Y, R and M, and B and C into a pair, respectively, and displaying RGB with the easy display of halftone, without applying a burden to the drive system of liquid crystal.

[0015]

[Example] The example of creation of the spectral characteristic of drawing 6 and the yellow of a color filter with the data of the chromaticity diagram of drawing 9, a Magenta, and the color pattern

of cyanogen is shown. It is the solvent which is a metal-containing azo system color as coating liquid for color pattern creation about the yellow of one amorous glance. The coloring liquid which added as an additive the metal complex for 4400g of polyimide precursor solutions which contain a solvent in 60g and 100g of resin solid content for yellow 63, a silane coupling agent, a surface treatment agent, and light-fast improvement was prepared. This coloring liquid — using it — a law — by the method, coating, patterning, and BEKU processing were performed and the color pattern of yellow was formed. The thickness was 0.3 micrometers, moreover, about the cyanogen of two amorous glance, it is a triphenylmethane color system color as coating liquid for color pattern creation — acid The coloring liquid which added as an additive the metal complex for 3900g of polyimide precursor solutions which contain a solvent in 25g and 100g of resin solid content for blue 9, a silane coupling agent, a surface treatment agent, and light-fast improvement was prepared. This coloring liquid was used and the color pattern of cyanogen was formed like the front. At that time, some color patterns were piled up with the color pattern of the yellow of one amorous glance, and the pattern (color element) of Green was also formed. The thickness of the color pattern of the cyanogen was 0.39 micrometers. Furthermore, about the Magenta of three amorous glance, the coloring liquid which added as an additive the metal complex for 3400g of polyimide precursor solutions which contain a solvent in 14.4g and 100g of resin solid content for LJ red 319H (DAIWA formation make, a trade name) which are a xanthene system color as coating liquid for color pattern creation, a silane coupling agent, a surface treatment agent, and light-fast improvement was prepared. This coloring liquid was used and the color pattern of a Magenta was formed like the front. At that time, some color patterns were piled up with each pattern of one amorous glance and two amorous glance, and blue and both the patterns (color element) of red were also formed. The thickness of the color pattern of the Magenta was 0.35 micrometers. As occasion demands, a protective coat (the so-called topcoat) can be formed on each color pattern. Here, about the formation sequence of each color pattern, more preferably, in order to make smaller previously a level difference [ in / for what has higher thermal resistance / a superposition part ] in consideration of BEKU processing again, it is good to set up the small thing of thickness previously, respectively. Therefore, the formation sequence of the cyanogen of two amorous glance and the Magenta of three amorous glance can be replaced from such a viewpoint.

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## CLAIMS

## [Claim(s)]

[Claim 1] It is the color filter arranged so that a liquid crystal layer may be faced on a transparency substrate. It has a color filter layer containing yellow, a Magenta, and the color pattern of at least two or more colors in cyanogen. This color filter layer It has the becoming one-layer part and the bilayer part to which yellow, a Magenta, and any two color patterns in cyanogen overlapped the bilayer. yellow, a Magenta, and any one color pattern of cyanogen — much more — since — by the bilayer part Red, Green, the color filter for liquid crystal displays characterized by forming one of blue primary colors.

[Claim 2] The color filter of claim 1 with which said one-layer part and said bilayer part have been arranged by turns on said transparency substrate.

[Claim 3] Said color filter is a color filter of claim 1 which is an object for the liquid crystal displays of the reflective mold with which it is reflected by the side on the other hand, and the light which carries out incidence from the whole surface of said color filter layer passes through the inside of a color filter layer twice.

[Claim 4] Said color filter layer is a color filter of claim 3 whose thickness of said one-layer part it consists of resin and color material which colors it, and is 0.7 micrometers – 0.2 micrometers.

[Claim 5] The color filter of claim 3 whose minimum value of the spectral transmittance in the wavelength of 420nm – 610nm of said color filter layer is 4 – 40% in each color.

[Claim 6] It is the color filter of claim 1 with which said one-layer part and said bilayer part constitute the color element for color display, and said color filter layer is equipped with the color element of yellow, a Magenta, cyanogen, red, Green, and six blue colors.

[Claim 7] Claim 1 or 6 color filters with which what has a complementary color relation mutually with red to Green and cyanogen to blue and a Magenta to yellow adjoins each other.

[Claim 8] The color filter of claim 7 which displays on coincidence the part of the complementary color which adjoins said primary color.

[Claim 9] The color filter of claim 6 which makes a pair each color element of yellow, Green and cyanogen, blue or red, and a Magenta, respectively, and displays a RGB system.

[Claim 10] It is the color filter arranged so that a liquid crystal layer may be faced on a transparency substrate. It has a color filter layer containing yellow, a Magenta, and the color pattern of three colors of cyanogen. This color filter layer